

CLAIMS:

[0044] The embodiments of the invention in which an exclusive property or privilege is claimed are defined, as follows:

1. In load lock apparatus for facilitating transfer of parts between a room at ambient atmospheric pressure and a vacuum processing chamber maintained at a pressure less than one (1) torr, wherein the load lock apparatus has an evacuable load lock chamber, an exterior door positioned between the load lock chamber and the room, a interior door positioned between the load lock chamber and the processing chamber, a exterior door actuator that is responsive to an exterior door control signal to open or close the exterior door, an interior door actuator that is responsive to an interior door control signal to open or close the interior door, and a vacuum pump connected to the load lock chamber for evacuating the load lock chamber, the improvement comprising:

a combination differential and absolute pressure transducer with (i) a manifold connected in fluid flow relation to the load lock chamber so that pressure in the manifold is equal to pressure in the load lock chamber, (ii) a differential pressure sensor that is capable of sensing a pressure difference between a first side of the differential pressure sensor and a second side of the differential pressure sensor, said differential pressure sensor being connected to the manifold and mounted such that said first side is exposed to the ambient atmospheric pressure in the room and such that the second side is exposed to pressure in the manifold, (iii) a differential pressure transducer circuit

connected to the differential pressure sensor and which is capable of generating an exterior door control signal at a preset differential pressure value, (iv) an absolute pressure sensor that is capable of sensing absolute pressure, said absolute pressure sensor being connected to the manifold in such a manner that the absolute pressure sensor is exposed to pressure in the manifold, and (v) an absolute pressure transducer circuit connected to the absolute pressure sensor and which is capable of generating an interior door control signal at a preset absolute pressure value;

an exterior door control link connected between the differential pressure transducer circuit and the exterior door actuator, said exterior door control link being capable of delivering exterior door control signals generated by the differential pressure transducer circuit to the exterior door actuator; and

an interior door control link connected between the absolute pressure transducer circuit and the interior door actuator, said interior door control link being capable of delivering interior door control signals generated by the absolute pressure transducer circuit from the to the interior door actuator.

2. The improvement of claim 1, wherein the absolute pressure sensor of the combination differential and absolute pressure transducer comprises a pirani sensor with a resistivity that varies as a function of pressure in the manifold, and wherein the absolute pressure transducer circuit includes a pirani bridge circuit that incorporates the pirani sensor as a resistive element in the bridge circuit, an analog process circuit connected to the pirani bridge circuit to adjust

voltage across the pirani sensor as pressure in the manifold varies and thereby keep the bridge circuit in balance, and a relay control circuit that monitors voltage across the pirani sensor and generates the interior door control signal when the voltage across the pirani sensor is at a value that corresponds with said preset absolute pressure value.

3. The improvement of claim 1, wherein the differential pressure sensor of the combination differential and absolute pressure transducer comprises a capacitance manometer pressure sensor in which a capacitance varies as a function of differential pressure across a diaphragm that is positioned with the manifold pressure on one side of the diaphragm and ambient atmospheric pressure of the room on another side of the diaphragm, and wherein the differential pressure transducer circuit includes a sensor control circuit that is capable of converting the capacitance to a voltage that corresponds in value to the differential pressure across the diaphragm, and a relay control circuit that monitors the voltage from the sensor control circuit and generates the exterior door control signal when the voltage of the sensor control circuit corresponds with said preset differential pressure value.

4. Combination differential and absolute pressure transducer apparatus for controlling a load lock that facilitates transfer of parts between a room at ambient atmospheric pressure and a vacuum processing chamber maintained at a pressure less than one (1) torr and that has an evacuable load lock chamber, an exterior door positioned between the load lock chamber and the room, a interior door positioned between the load lock chamber and the processing chamber, a exterior door actuator that is responsive to an exterior door control signal

to open or close the exterior door, an interior door actuator that is responsive to an interior door control signal to open or close the interior door, and a vacuum pump connected to the load lock chamber for evacuating the load lock chamber, wherein combination differential and absolute pressure transducer comprises:

a differential pressure sensor that is capable of sensing a pressure difference between a first side of the differential pressure sensor and a second side of the differential pressure sensor, said differential pressure sensor being connected in fluid flow relation to the load lock chamber and mounted such that said first side is exposed to the ambient atmospheric pressure in the room and such that the second side is exposed to pressure in the load lock chamber;

a differential pressure transducer circuit connected to the differential pressure sensor and which is capable of generating an exterior door control signal at a preset differential pressure value;

an absolute pressure sensor that is capable of sensing absolute pressure, said absolute pressure sensor being connected in fluid flow relation to the load lock chamber in such a manner that the absolute pressure sensor is exposed to pressure in the load lock chamber;

an absolute pressure transducer circuit connected to the absolute pressure sensor and which is capable of generating an interior door control signal at a preset absolute pressure value.

5. The combination differential and absolute pressure transducer apparatus of claim 4, including:

an exterior door control link connected between the differential pressure transducer circuit and the exterior door actuator, said exterior door control link being capable of delivering exterior door control signals generated by the differential pressure transducer circuit to the exterior door actuator; and

an interior door control link connected between the absolute pressure transducer and the interior door actuator, said interior door control link being capable of delivering interior door control signals generated by the absolute pressure transducer circuit to the interior door actuator.

6. The combination differential and absolute pressure transducer apparatus of claim 4, wherein the absolute pressure sensor comprises a pirani sensor with a resistivity that varies as a function of pressure in the load lock chamber, and wherein the absolute pressure transducer circuit includes a pirani bridge circuit that incorporates the pirani sensor as a resistive element in the bridge circuit, an analog process circuit connected to the pirani bridge circuit to adjust voltage across the pirani sensor as pressure in the load lock chamber varies and thereby keep the bridge circuit in balance, and a relay control circuit that monitors voltage across the pirani sensor and generates the interior door control signal when the voltage across the pirani sensor is at a value that corresponds with said preset absolute pressure value.

7. The combination differential and absolute pressure transducer apparatus of claim 4, wherein the differential pressure sensor of the combination differential and absolute pressure transducer comprises a capacitance manometer pressure sensor in which a capacitance varies as a function of differential pressure across a diaphragm that is positioned with the load lock chamber pressure on one side of the diaphragm and ambient atmospheric pressure of the room on another side of the diaphragm, and wherein the differential pressure transducer circuit includes a sensor control circuit that is capable of converting the capacitance to a voltage that corresponds in value to the differential pressure across the diaphragm, and a relay control circuit that monitors the voltage from the sensor control circuit and generates the exterior door control signal when the voltage of the sensor control circuit corresponds with said preset differential pressure value.

8. A method of automatically controlling a load lock that facilitates transfer of parts between a room at ambient atmospheric pressure and a vacuum processing chamber maintained at a pressure less than one (1) torr and that has an evacuable load lock chamber, an exterior door positioned between the load lock chamber and the room, a interior door positioned between the load lock chamber and the processing chamber, a exterior door actuator that is responsive to an exterior door control signal to open or close the exterior door, an interior door actuator that is responsive to an interior door control signal to open or close the interior door, and a vacuum pump connected to the load lock chamber for evacuating the load lock chamber, comprising:

sensing differential pressure between the load lock chamber and the ambient pressure in the room;

transducing the sensed differential pressure to a voltage that corresponds in value to the sensed differential pressure;

producing a differential pressure reference voltage that corresponds in value to the voltage that is transduced from the differential pressure when the differential pressure is at a desired differential pressure value for opening the exterior door;

comparing the differential pressure reference voltage to the transduced voltage that corresponds in value to the differential pressure, and, when the transduced voltage equals the differential pressure reference voltage, producing the exterior door control signal and delivering the exterior door control signal to the exterior door actuator sensing absolute pressure in the load lock chamber;

transducing the sensed absolute pressure to a voltage that corresponds in value to the absolute pressure;

producing an absolute pressure reference voltage that corresponds in value to the voltage that is transduced from the absolute pressure when the absolute pressure is at a desired absolute pressure for opening the interior door;

comparing the absolute pressure reference voltage to the transduced voltage that corresponds in value to the voltage that is transduced from the absolute pressure when the absolute pressure is at a desired absolute pressure value for opening the interior door; and

comparing the absolute pressure reference voltage to the transduced voltage that corresponds in value to the absolute pressure, and, when the transduced voltage equals the absolute pressure reference voltage, producing the exterior door control signal and delivering the interior door control signal to the interior door actuator.

9. A method of automatically controlling a load lock that facilitates transfer of parts between a room at ambient atmospheric pressure and a vacuum processing chamber maintained at a pressure less than one (1) torr and that has an evacuable load lock chamber, an exterior door positioned between the load lock chamber and the room, a interior door positioned between the load lock chamber and the processing chamber, a exterior door actuator that is responsive to an exterior door control signal to open or close the exterior door, an interior door actuator that is responsive to an interior door control signal to open or close the interior door, and a vacuum pump connected to the load lock chamber for evacuating the load lock chamber, comprising:
predetermining a desired differential pressure value at which to open the external door, and
predetermining a desired absolute pressure value at which to open the internal door;

sensing actual differential pressure between the load lock chamber and the ambient pressure in the room;

comparing the actual differential pressure to the predetermined differential pressure value, and, when the actual differential pressure equals the predetermined differential pressure value, producing the exterior door control signal and delivering the exterior door control signal to the exterior door actuator;

sensing actual absolute pressure in the load lock chamber; and
comparing the actual absolute pressure to the predetermined absolute
pressure value, and, when the actual absolute pressure equals the predetermined absolute
pressure value, producing the interior door control signal and delivering the interior door
control signal to the interior door actuator.